

The background of the slide features a large, faint, circular seal of the Federal Bureau of Investigation (FBI) Science and Technology Branch. The seal contains a globe, a microscope, and a test tube, with the words "FEDERAL BUREAU OF INVESTIGATION" and "SCIENCE AND TECHNOLOGY" visible around the perimeter.

Improving the Process: What could help forensic examiners make better decisions?

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Disclaimer

The views expressed are those of the presenter and do not represent those of the Federal Bureau of Investigation, the United States Department of Justice, nor the United States Government.

Outline

- Biometrics vs. Forensics and Expert Evidence
- Process Used by Forensic Examiners Today
- What kind of R&D can help with this process?
 - How to fuse?
 - Instructions for Enrollment
 - Research (ID by parts; covariates – Feature Variability)
 - Tools for the Examiner (heat map; pose, expression, aging)

Biometrics “versus” Forensics



Biometrics

- A measurable biological (anatomical and physiological) or behavioral characteristic used for identification
 - Facial Recognition (FR) - the **automated** searching of a facial image in a computer database, typically resulting in a group of facial images ranked by computer-evaluated similarity

Event

Forensics



- Visible physical characteristics one can use for the purposes of measurements or comparisons that are collected after an event
 - Facial Identification (FI) - the **manual** examination of the differences and similarities between two facial images for the purpose of determining if they represent different persons or the same person

Biometrics “versus” Forensics

- Biometric tools can be used to assist in forensic exams, with latest research indicating fusion with examiners may improve results.
 - Phillips, et al., PNAS 2018 “Face recognition accuracy of forensic examiners, superrecognizers, and algorithms”
- Cannot use FR algorithms as a “Red Light / Green Light” system
- How do we fuse? (Simple averaging?)

Sidebar – Enrollment Guidance?

- Law Enforcement and other users of FR systems need guidance on enrollment processes.
 - ANSI/NIST-ITL 1-2011 Update: 2015 Mug Shot Standard – “5 Pack”
- Advanced FR algorithms utilize video (tracks) or multi-image inputs to generate templates for matching.
- WHAT SHOULD WE DO NOW???
 - 18,000+ LE agencies will need to adapt.

Forensic Science - Criticism & Responses

- NRC/NAS Report on Strengthening Forensic Science in the United States (2009)
- PCAST Report (2016)
- Critical of current state of most disciplines.

Key/Relevant Recommendations include:

- Expand research on the accuracy, reliability, and validity of the forensic sciences; and
- Develop tools for advancing measurement, validation, reliability...and to establish protocols for examinations, methods, and practices.

Forensic Science - Criticism & Responses

- National Commission on Forensic Science (NCFS)
- Organization of Scientific Area Committees for Forensic Science (OSAC)
- NIST Forensic Science Center of Excellence
 - Advance the Utility of *Probabilistic* Methods to Enhance Forensic Analysis
- NIJ Forensic Technology Center of Excellence
- DOJ FSWG (e.g., ULTRs)

Defining the Scope of Forensic Analyses

Deterministic versus Probabilistic

- All data is known beforehand.
 - Initial conditions define the final result

Versus

- Element of Chance is Involved
- AFR (and Facial Identification) – Pattern Analysis
 - NOT Biologically Defined?
 - NOT Deterministic...or is it?
 - Face from DNA?

Defining the Scope of Forensic Analyses

- What can we say and how do we validate it?
- Patterned Evidence Disciplines - Approaches
 - Human Performance Testing (“Black Box”, “White Box”)
- A path forward – Can we improve human/examiner performance?

Improving Patterned Evidence Analyses

- Process of Analyses – Use “ACE” model:
 - Analyze Quality and Content of Evidence (Observations)
 - Compare Observations (Similarities and Differences)
 - Evaluate Significance of these (Conclusion)
 - *(Shout out to later presentation...)*
- Latent Print Study
 - Analysis Phase Served as Predictor of Performance

Improving Patterned Evidence Analyses

- **Latent Print Study**

- Analysis Phase Served as Predictor of Performance
- Develop tools to assess quality of data automatically

- **Challenge to developers – improve automation**

- Latent Print Similarity of Pattern (getting much better – lights out latent?)
- Can we find a meaningful, universal metric of “facial similarity” or “feature similarity”?

- **CAVEAT – Similarity vs. “Identity” (or “Individualization”)**

Facial Image Analysis

- AFR algorithms determine similarity of patterns
- Similarity above a given threshold = “match”
 - Stochastic determination (no intrinsic model of identity)
- Low-Scoring True-Match Pairs Happen
AND
- High Scoring Non-Match Pairs Happen

Facial Image Analysis

- Low-Scoring True-Match Pairs Happen (FR is BRITTLE!)
 - ...and is not designed to exclude (“eliminate”)



Facial Image Analysis

- SOTA AFR is not good enough for lights out.
 - Must rely on human decision makers
- Features used in AFR not *deliberately* based on physical manifestation of biology (e.g., nose, eyes)
 - ...but may unintentionally reflect intrinsic differences
 - Reflects performance variation with demographics?

Validating & Improving Facial Image Analysis

- ✓ Validate through Performance Testing (“Black Box”)
 - Statistics of Human Performance (PNAS, Phillips et al.)
- Validate/Define Degree to Which Faces are Unique
 - Can’t Sample Every Face on Planet
 - Don’t Have Deterministic Model of Facial Features (...yet?)
 - ...so what do we do?

Validating & Improving Facial Image Analysis

- Correlate Algorithms' Feature Sets to Biology
 - What features are most useful for discrimination and identification using AFR?
 - Ex: JANUS AFR system that “shows” regions of ‘strong’ and ‘weak’ match
 - Focus studies of features to define how “unique” each face is...

Validating & Improving Facial Image Analysis

- Challenge for Face – Features Change
- Features Change – How do we address?
 - Currently Examiners consider what is “possible.”
- Modeling of Change – What is possible for examiner
 - Age and Expression
 - Develop tools that show examiner the range of possible

CHALLENGES FOR MORPHOLOGICAL ANALYSIS

- Aging
- Examiners must consider what is possible...
- There is no fixed “guide”.



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CHALLENGES FOR MORPHOLOGICAL ANALYSIS

- Aging
- How much change in these features can we predict and how accurate can we be?
- Eyes (and Eyebrows)
- Nose
- Mouth
- Facial Lines



CHALLENGES FOR MORPHOLOGICAL ANALYSIS

- Aging Research
- Anatomically based models of facial aging being developed.
- Need to be able to provide examiner with “range of possibilities” against which comparisons can be judged.



CHALLENGES FOR MORPHOLOGICAL ANALYSIS

- UNCW/I2SIS Age Progression Models
- Eyes, nose and mouth modified...

Synthesized Face



Age Progression

Synthesized Face



Age Progression

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CHALLENGES FOR MORPHOLOGICAL ANALYSIS

- Expression
- 3D Modeling of face and 3D Avatars being generated and used extensively.
- Why not create same for forensic examiners?

CHALLENGES

- Expression

L ANALYSIS



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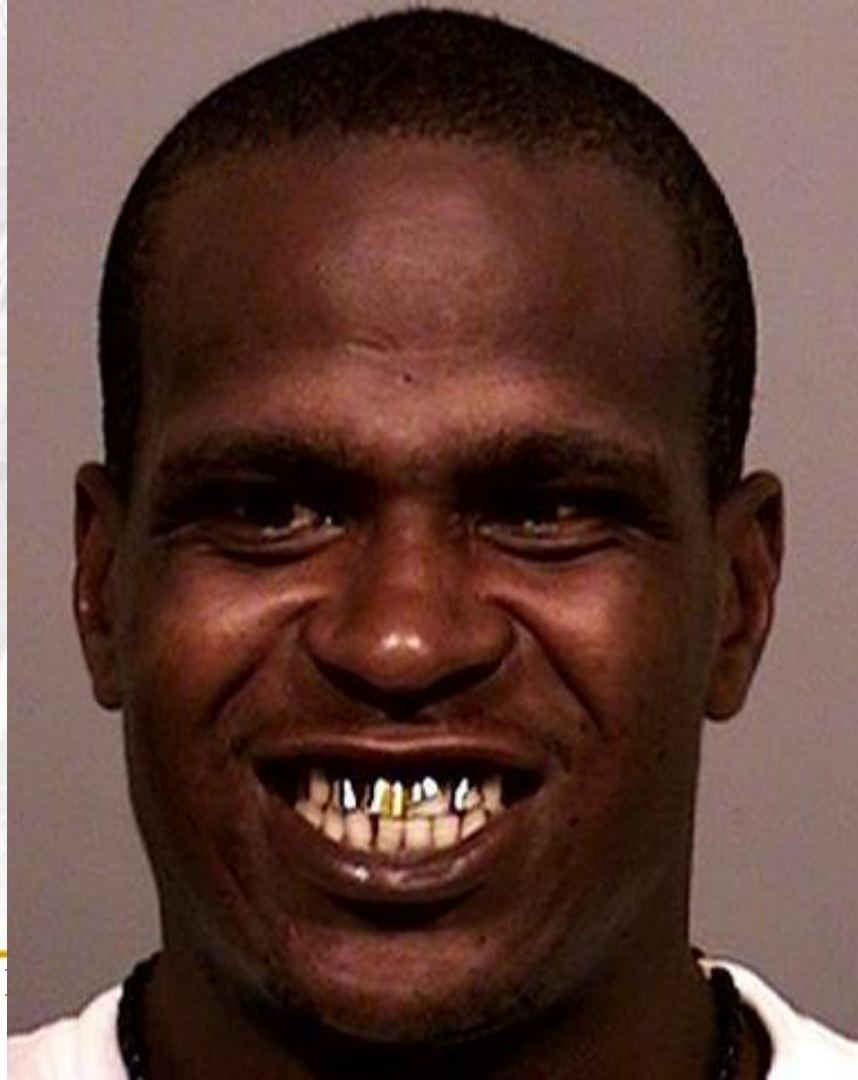
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CHALLENGES

- Expression

L ANALYSIS



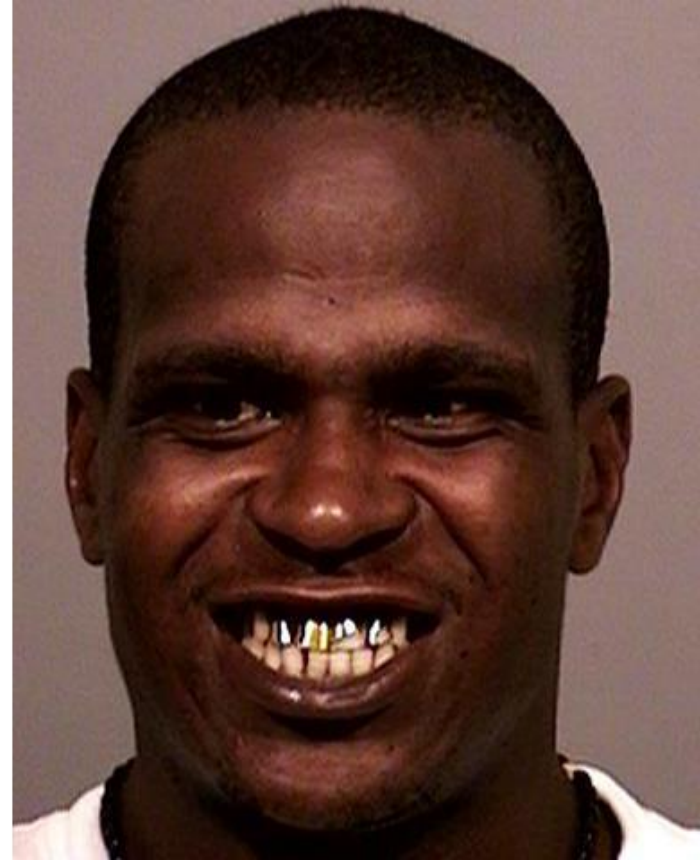
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CHALLENGES FOR MORPHOLOGICAL ANALYSIS

- Expression
- Eyes
- Nose
- Mouth



CHALLENGES FOR MORPHOLOGICAL ANALYSIS

- Anatomical modeling can be used to inform examiners of the range of the possible.
- “Is the observed variation in features between the two images possible within accepted anatomical norms?”



Enrollment Challenge

- 3D Modeling of face and 3D Avatars being generated and used extensively.
- Why not create same for forensic examiners?

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Summary thoughts & Questions?

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